e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

EXPERIMENTAL STUDY OF STRENGHT OF CONCRETE BY USING OPTICAL FIBER

Piyush P. Kharade[*1], Akash S. Nazirkar[*2], Niketan S. Kolekar[*3], Suyash M. Kharade[*4], Thaksen M. Nanwar[*5], Jayashri M. Khatal[*6]

[*1,2,3,4,5]Student B.E. Department Of Civil Engineering, S.S.P.M's Sharadchandra Pawar College of Engg & Technology, Someshwarnagar. Maharashtra, India.

[*6]Assistant Professor, Department Of Civil Engineering, S.S.P.M's Sharadchandra Pawar College of Engg & Technology, Someshwarnagar, Maharashtra, India.

ABSTRACT

Building energy saving and safe evaluation for engineering structures have obtained the worldwide attention. It is much of importance for developing a new kind of building material, which can integrate green energy saving with self sensing properties of functional material. based on the excellent properties of light guiding and elastic optic effect of Optical Fiber, a novel smart transparent concrete is researched by arranging the optical fibers into the concrete. To evaluate the effectiveness of the smart transparent concrete, the light guiding based on white light test, long-term durability based on freezing and thawing test are made respectively. The experiments result show that the smart transparent concrete has good self-sensing properties by using of the optical fiber in concrete.

Keywords: Optical Fiber, Compressive Strength, Flexural Strength, Environment, Reuse.

I. INTRODUCTION

Litracon present the phenomenon of light transmitting concrete in the form of widely applicable new building materials. Litracon is a combination of optical fibers and fine concrete. It can be produced as prefabricated buildings blocs and panels. Due to small size of fabrics, they blend in to concrete becoming a component of material like small pieces of aggregate. The plastic fibers lead light by point between two sides of the blocks. Because of their parallel position, the light information on the brighter side of such a wall appears darker side. The most interesting from of this phenomenon is probably the sharp display of shadows on the opposing side of the wall. Moreover.

Thousands of optical fibers from a matrix and run parallel to each other between the two main surfaces of each block. The proportion of fibers is very small (4%) compared to the total volume of the block. Moreover, these mingle in the concrete because of their in significant size, and they become a structural component as a kind of modest aggregate. Therefore, the surface if the blocks remain homogeneous concrete. In theory, a wall structure built from light- transmitting concrete can be several meters thick, because the fibers work without almost any loss in light up until 20 meters. Load-bearing structure can be also built of these blocks, since plastic Fibers do not have a negative effect on the well-known high compressive strength value of concrete. The block can be produced in the various sizes and with embedded heat-isolation.

Concrete by using Optical fiber

An optical fiber is a flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair. Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than wire cables. Fibers are used instead of metal wires because signals travel along them with lesser amounts of loss; in addition, fibers are also immune to electromagnetic interference, a problem from which metal wires suffer excessively. Fibers are also used for illumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces, as in the case of a fiber scope. Specially designed fibers are also used for a variety of other applications, some of them being fiber optic sensors and fiber lasers. Optical fibers typically include a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fiber to act as a wave guide. Fibers that support many propagation paths or transverse modes are called multi-mode fibers (MMF), while those

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

that support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally have a wider core diameter and are used for short-distance communication links and for applications where high power must be transmitted.

II. MATERIALS USED IN EXPERIMENTAL WORK

A. Cement

Cement is a well known binding material and has occupied an indispensable place in construction works there are a variety of cement available in the market and each type is used under certain condition due to its special properties. The cement commonly used is Ordinary Portland cement in this project we are using 53 Grade cement. Accordingly the relevant test method may be choose from amongst the various test covered as per IS: 4031 (part-3) - 1996.

Table 1: Physical Properties Of Cement

Sr. No	Property	Results
1	Specific Gravity	3.15
2	Initial setting time	160 min
3	Final setting time	240 min
4	Fineness of cement	4%
5	Standard consistency	32%

B. Aggregate

Aggregate properties greatly influence the behaviour of concrete since they occupy 80% of the total volume of concrete. The aggregates are classified as Fine Aggregate & Coarse Aggregate. These aggregate are generally obtained from natural deposits of sand and gravel or from quarries by cutting rocks. Accordingly, the relevant test methods may be chosen from among the various tests covered as per IS: 2386 (Part-3)-1963

Table 2: Physical Properties Of Coarse Aggregate

Sr. No	Name of test	Result
1	Particle size	20mm
2	Specific gravity	2.5
3	Water absorption	1%

Table 3: Physical Properties Of Coarse Aggregate

Sr. No	Name of test	Result
1	Particle size zone	Zone I
2	Specific gravity	2.6
3	Water absorption	0.5%

C. Optical fiber

An optical fiber is a flexible, transparent fiber made of extruded glass (silica) or plastic, slightly thicker than a human hair. It can function as a waveguide, or “light pipe”, to transmit light between the two ends of the fiber. The field of applied science and engineering concerned with the design and application of optical fibers is known as fiber optics.

Optical fibers are widely used in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths than wire cables. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Fibers are also used for illumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces. Specially designed fibers are used for a variety of other applications, including sensors and fiber lasers Optical fibers typically include a transparent core surrounded by a transparent cladding material

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

with a lower index of refraction. Light is kept in the core by total internal reflection. This causes the fiber to act as a waveguide.

Mix proportioning

The mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportion with the object of producing concrete of certain minimum strength and durability as economically as possible. By using IS code IS 10262-2019.

Mix proportion for 1 m^3 concrete

- ✓ Cement = 458kg/m^3
- ✓ Water = 192 kg/m^3
- ✓ Fine aggregate = 662kg/m^3
- ✓ Coarse aggregate = 1022kg/m^3
- ✓ Water cement ratio = 0.42

III. EXPERIMENTAL WORK

The percentage of optical fiber is varied from 0 to 2 % with interval of 0.5%. The optical fiber is replaced with quantity of Aggregate with specified percentage and it has been used as mixing aggregate for experimental work.

A. Test conducted on fresh concrete-

Slump Cone Test-Slump of fresh concrete is done to determine the workability of fresh concrete by Slump cone test IS1199-2018 Part – 2. The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

B. Test conducted on hardened concrete-

Compressive strength of concrete Compressive test is important test conducted on harden concrete because most of the desired characteristics of concrete are qualitatively related to compressive strength, The main objective of the test is control of quality and to check that the concrete at site has developed required strength. The failure load was noted. For each percentage three cubes were tested and their average value is reported. The compressive strength was calculated as follows-

$$\text{Compressive Strength (MPa)} = \frac{\text{Failure load}}{\text{cross sectional area}}$$

$$F_c = \frac{P}{A}$$

Where,

P = Failure load in compression (N)

A = Loaded area of cube (mm^2)

C. Test conducted on hardened concrete-

Flexural strength of concrete Flexural strength test is method often used to determine the modulus of rupture of beam. It is often expressed as concrete modulus of rupture. Specimens are tested to failure using universal testing machine for 7 and 28-day curing age respectively. The test is conducted using four-point loading arrangement and the maximum load at failure is recorded.

IV. METHODOLOGY

1. Procurement of Materials
2. Testing of Materials
3. Arriving mix Proportion
4. Testing of fresh concrete
5. Casting & curing of concrete

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

6. Strength Investigation
7. Compressive Test
8. Flexural Test
9. Result & Discussion

V. RESULTS AND DISCUSSION

Compressive Strength test on concrete-

The compressive strength of the conventional concrete cube and optical fiber concrete cube in 7 and 28 days is carried out. Total no of 12 cubes where casted. Average of three cubes will be considered for the compression strength of these cubes. The test was carried out in an CTM machine. The compressive strength of the concrete is determined by cast the cubes of size 150mm x150mm x150mm. The test results are shown in Table.

Test Results of conventional concrete cube

Sr. No.	Days	Load (KN)	Compressive stress (MPa)	Average Compressive stress (MPa)
1	7	838.35	37.26	38.58
2		900.45	40.02	
3		865.35	38.46	
4	28	949.725	42.21	43.89
5		980.32	43.57	
6		1032.25	45.89	

Test Results of Concrete cube With Optical Fibre

Sr. No.	Days	Load (KN)	Compressive stress (MPa)	Average Compressive stress (MPa)
1	7	904.72	40.21	41.56
2		967.95	43.02	
3		932.850	41.46	
4	28	967.75	43.00	44.38
5		993.37	44.15	
6		103.52	46.01	

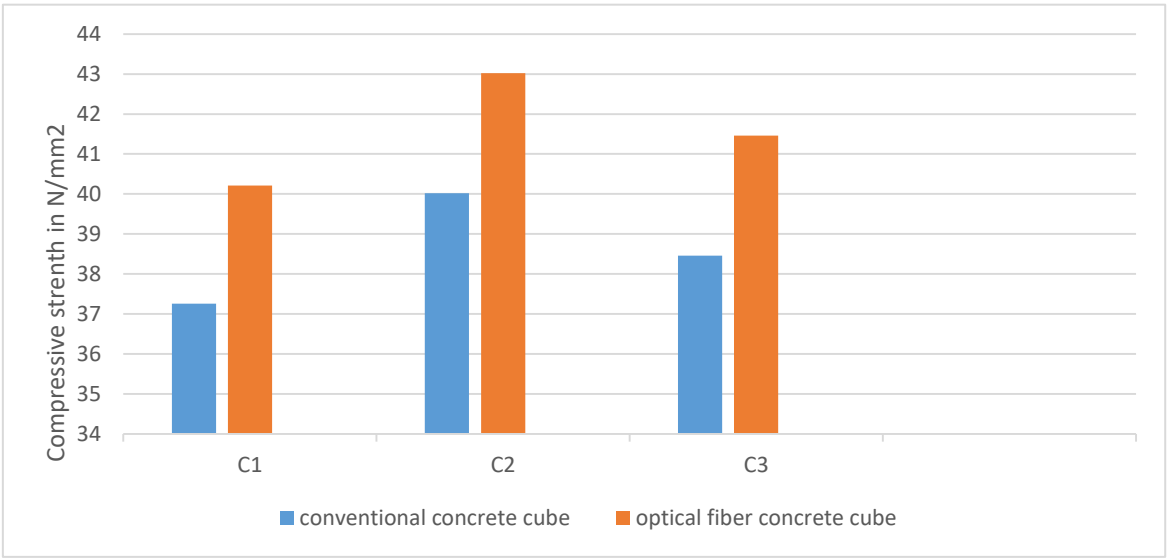

Figure 1: Graphical representation of compressive strength test result 7 Days

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

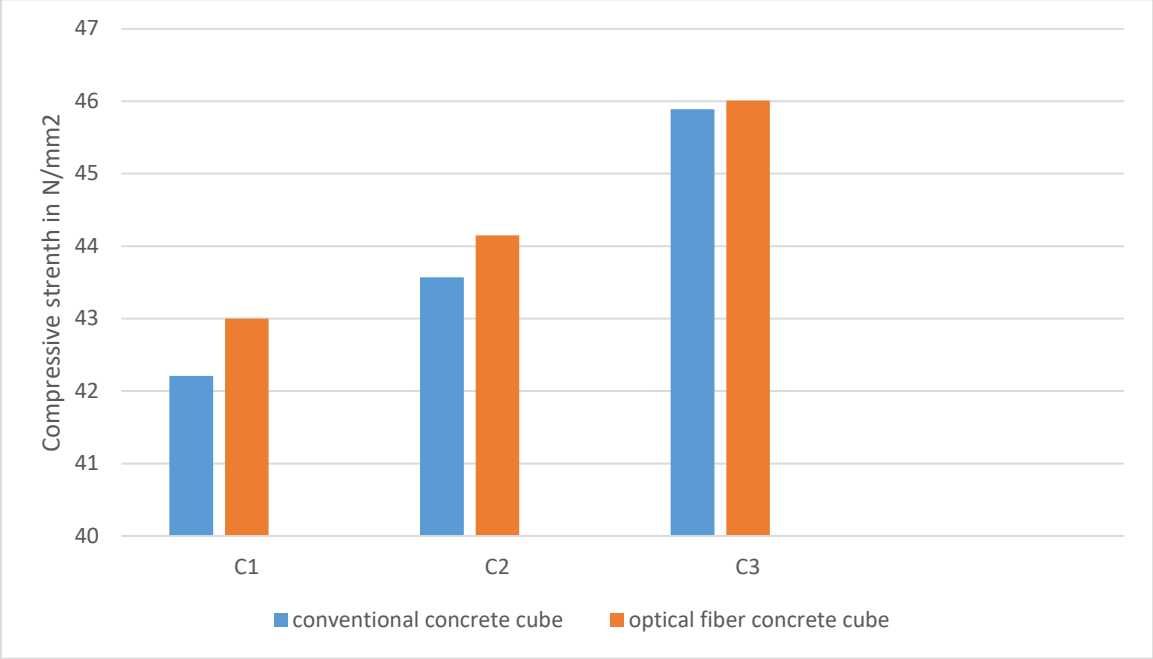

Figure 2: Graphical representation of compressive strength test result 28 Days

Flexural Strength test on concrete-

For Determination of the flexural strength, cubes were casted in the experimental study A total number of 12 beams were casted. Three beams were casted for 7 days of curing test and three beams were casted for 28 days curing test. Average of three cubes will be considered for the compression strength of these cubes. The test was carried out in an UTM machine. The flexural strength of the concrete is determined by casting of beam of size 700mm x150mm x150mm. The test results are shown in Table.

Test Results of Normal Concrete Beam

Sr. No.	Days	Load (KN)	flexural strength (MPa)	Average flexural strength (MPa)
1	7	14.46	3	3.11
2		15.13	3.14	
3		15.42	3.20	
4	28	17.11	3.55	3.66
5		17.79	3.69	
6		18.08	3.75	

Test results of Concrete Beam with Optical Fibre

Sr. No.	Days	Load (KN)	flexural strength (MPa)	Average flexural strength (MPa)
1	7	14.94	3.10	3.24
2		15.38	3.19	
3		16.63	3.45	
4	28	17.59	3.65	3.72
5		17.93	3.72	
6		18.32	3.80	

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

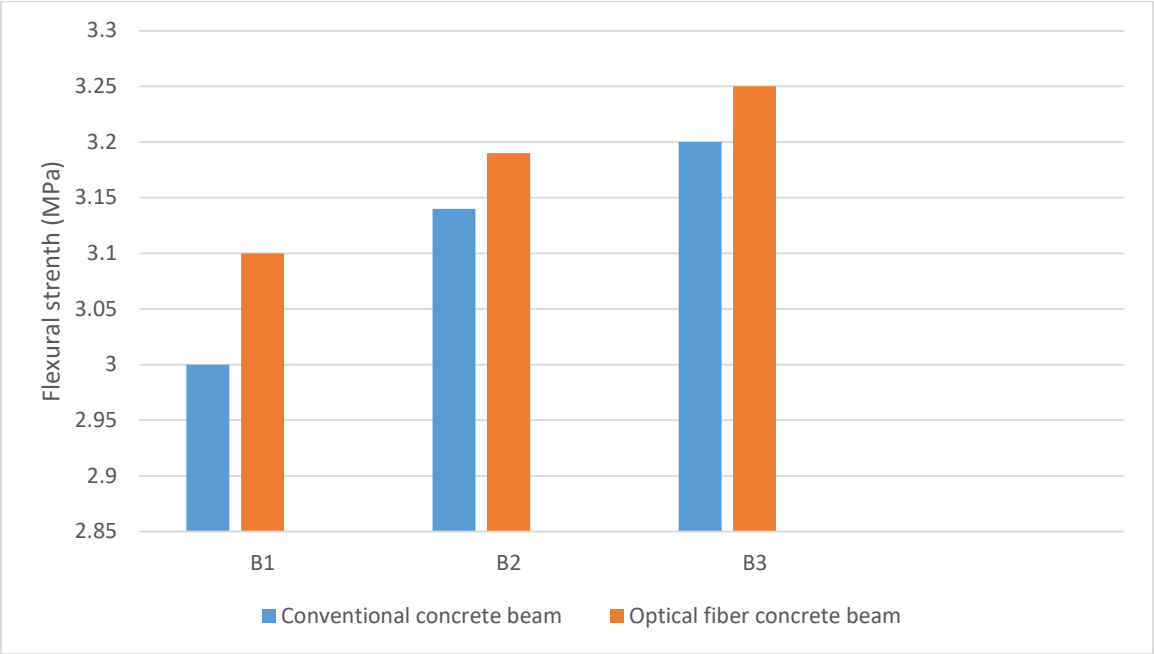

Figure 3: Graphical representation of Flexure test result 7 Days

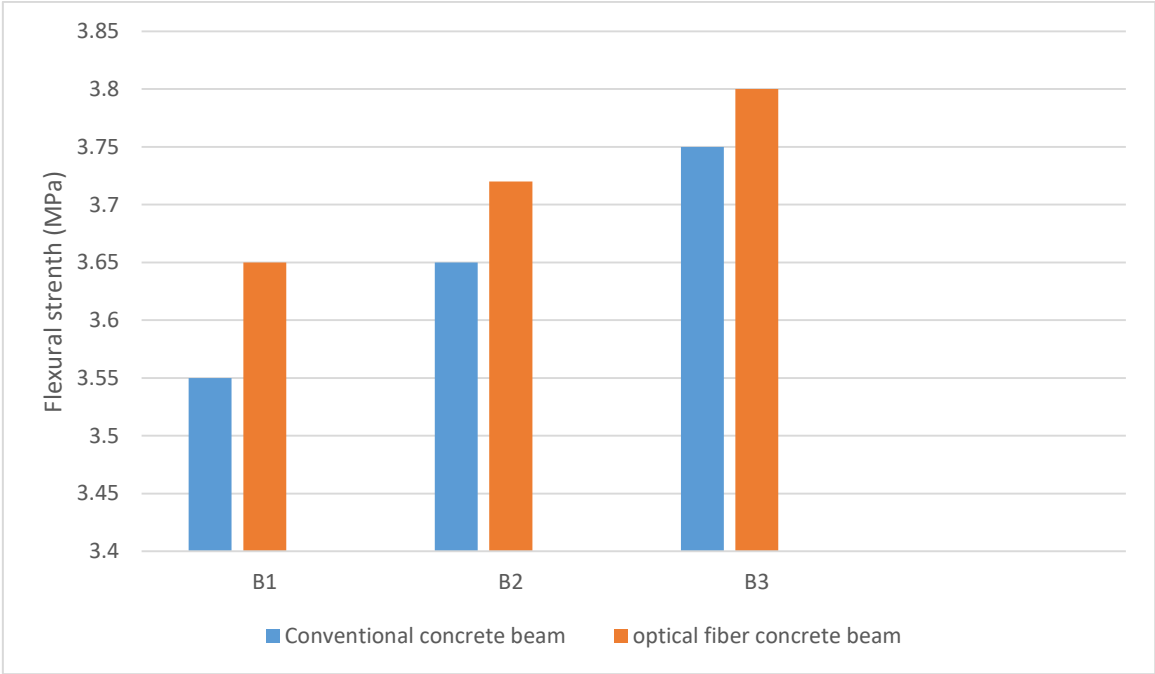

Figure 4: Graphical representation of Flexure test result 28 Days

VI. CONCLUSION

- The efficiency of the application of optical fibre is studied by comparing the strength with the normal M40 grade concrete and the test results proved that the efficiency is more in all aspect.
- In compressive test the the result of 7 days of optical fiber concrete cube is increased by 7.17% and at 28 days increased by 1.10% as compared to conventional concrete cube.
- Further in Flexural test the the result of 7 days of optical fiber concrete beam is increased by 4.01% and at 28 days increased by 1.61% as compared to conventional concrete beam.
- For this experimental work it is clear that concrete by using optical fiber shows improved strength than conventional concrete hence it is recommended that concrete by using optical fiber in beams are used as structular members.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

VII. REFERENCES

[1] Neville, A.M., Properties of concrete , 4th addition John Wiley & sons Inc.,1996
[2] Mindness, S. and Young , JF., Concrete, Englewood Cliffs, New Jersey; Prentice Hall Inc.,1981
[3] Troxell G.E., Davis H.E., and Kelly J.W., Composition and Properties of Concrete, McGraw-Hill Book Company, New York, 1968
[4] Taylor W.H., Concrete Technology and Practice, McGraw-Hill Company, Sydney,1977.
[5] Arioglu E. and Arioglu N., Testing of Concrete Core Sample and Evaluation, 2nd Edition, Evrim Publisher, Istanbul, 1998.
[6] Z. Zhou, J.P. Ou, and B.Wang Smart FRP-OFGB Bars and their Application in Reinforced Concrete Beams. Proceeding of the first International Conferences on Structural Health Monitoring and Intelligent Structure, Japan: 861~866,2003.
[7] F. Ansari. Practical Implementation of Optical Fiber Sensors in Civil Structural Health Monitoring. Journal of Intelligent Material System and Structure, 18 (8): 879-889, 2007.
[8] Kalymnios*, D. (2005). Plastic Optical Fibers (POF) in sensing – current status and prospect, 17th International Conference on Optical Fiber Sensors SPIE, Vol. 5855, Bruges,Belgium.
[9] Kuang, K.S.C., Maalej, M. and Quek, S.T. (2006). Hybrid Optical Fiber sensor system based on Fiber Bragg grating and plastic optical Fibers for health monitoring of Engineering structures. SPIE, Volume. 6174(2).
[10] www.litracon.com